

90 mm and 35 mm Dipoles

Ramesh Gupta

Progress and Status

Status of 35 mm aperture dipole

- The spacing between the three pole wiggler and dipole is increased. The center of three pole wiggler is ~30 cm from the end of iron. The iron to iron gap is ~20 cm.
 - Saddle coils are replaced by flat racetrack coils.
 - Racetrack coils with smaller bend diameter (2" instead of 4") are examined.
- All of above work requires 3-d analysis – a time consuming undertaking both in terms of human time and computer time.

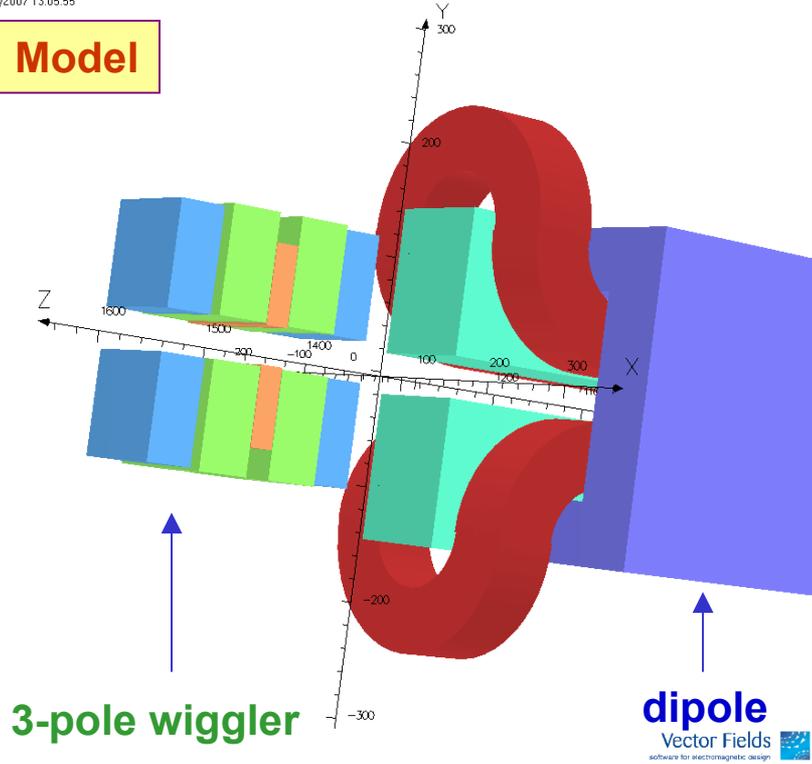
First optimized design of the larger aperture (90 mm) dipole:

- A number of 2-d designs have been examined.
- The desired goal is that the two dipoles (35 mm and 90 mm) run from the power supply.

Previous Design with ~9 cm iron to iron gap + "saddle coils" and "extended pole" for space saving features

21/Mar/2007 13:05:55

Model

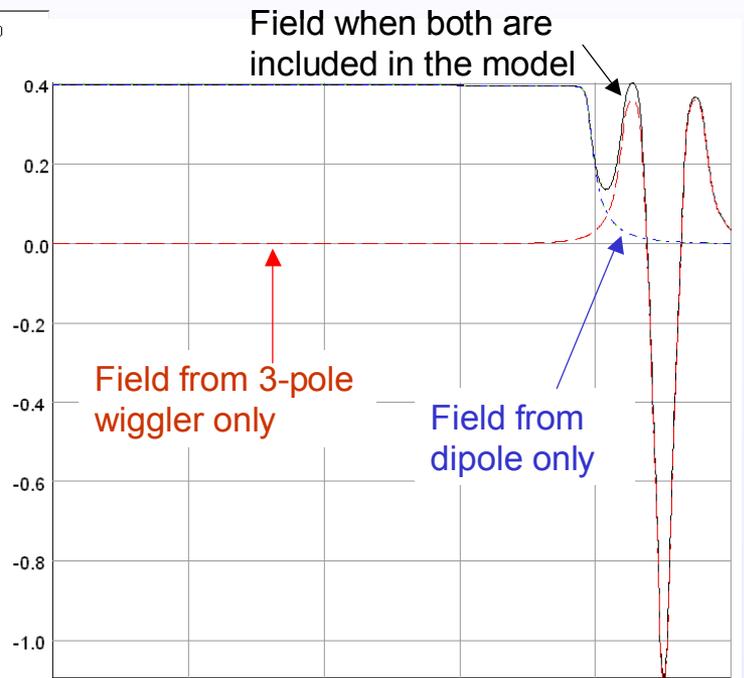


UNITS
Length
Magn Flux Dens
Magn Field
Magn Scalar Pot
Magn Vector Pot
Elec Flux Densit
Elec Field
Conductivity
Current Density
Power
Force
Energy

PROBLEM DATA
bedstd-3pole-6h.
TOSCA Magneto
Nonlinear materi
Simulation No 1 c
2628527 element
445743 nodes
5 conductors
Nodally interpole
Activated in glob
Reflection in XY p
Reflection in ZX p

Field Point Loc
Local = Global

21/Mar/2007 08:16:00



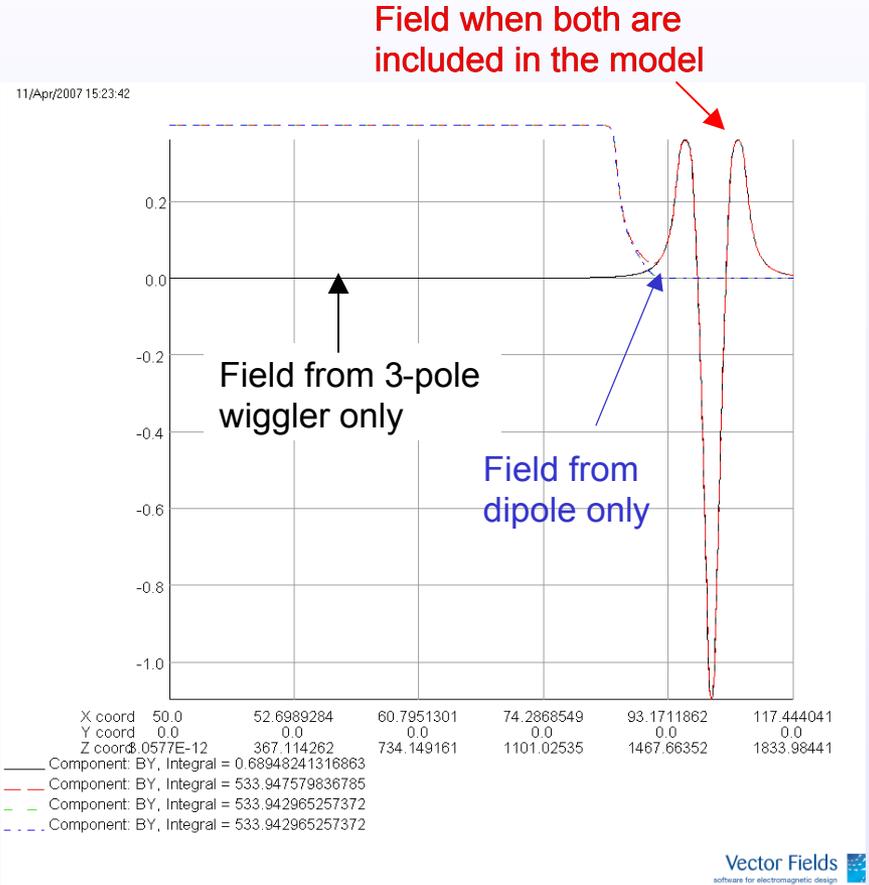
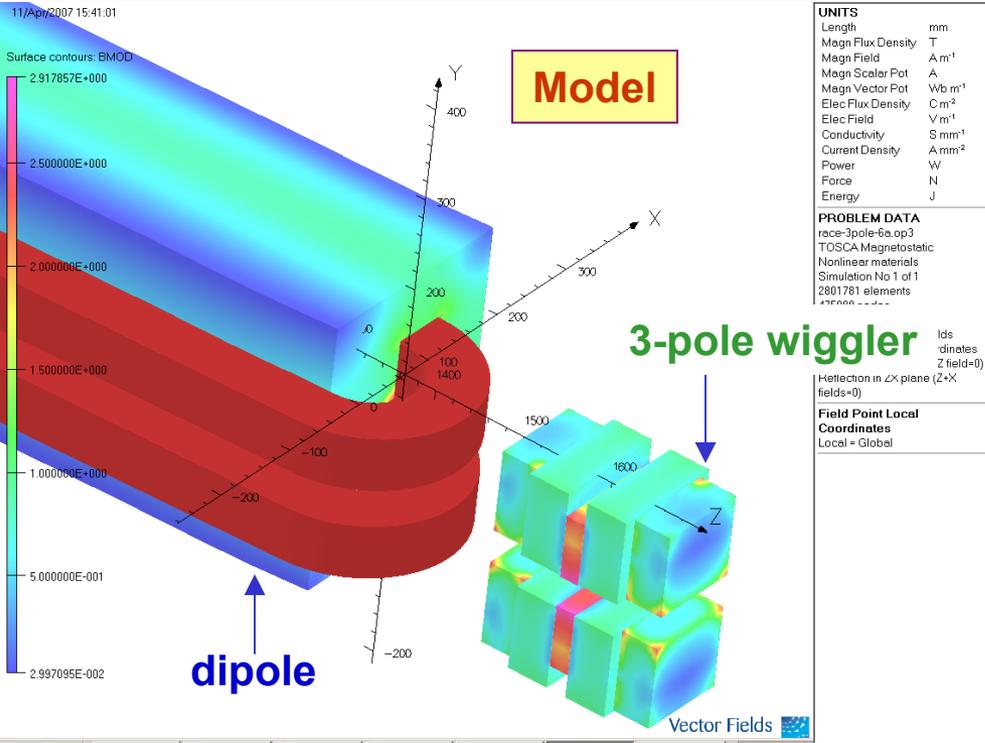
X coord	50.0	52.2086223	58.8340983	69.875256	85.3301421	105.191
Y coord	0.0	0.0	0.0	0.0	0.0	0.0
Z coord	0.0577E-12	332.099659	664.140567	996.063983	1327.81119	1659.3
Component: BY, Integral =	530.878028067497					
Component: BY, Integral =	-0.5699705835207					
Component: BY, Integral =	532.108379900017					

- Compare the integral field of the two when they are close and when they are far off (only dipole)
- But what about the field harmonics ?

Two field profiles with the same integral field may have vastly different field harmonics.

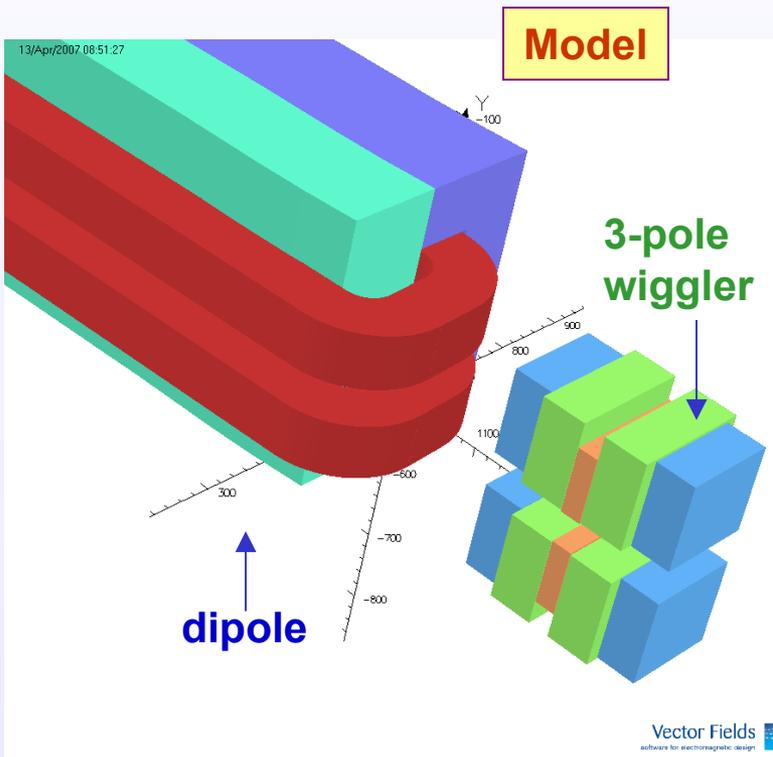
Generally more up and down in the field fall-off, indicates larger peaks in local harmonics (however, integral harmonics may be more relevant)

New design with racetrack coils ~20 cm iron to iron gap (~ 9 cm coil to iron gap)



• There is virtually no interference (within computational errors, < few parts in 1,000) between the fields of three pole wiggler and dipole.

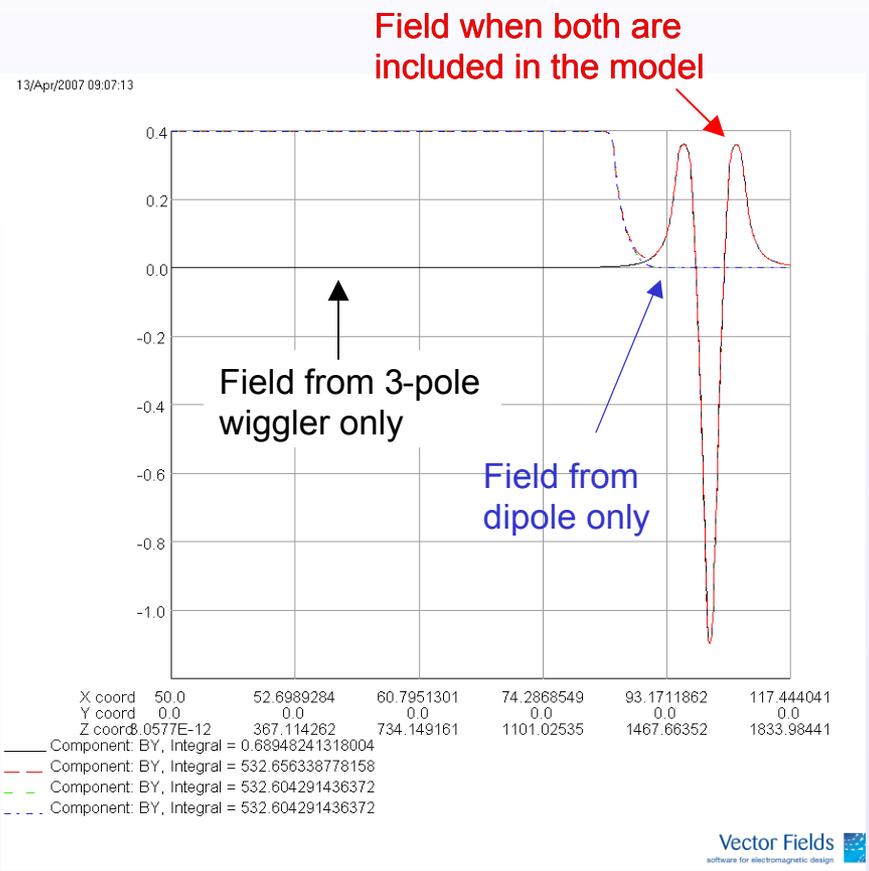
**New design with 2" bend diameter
racetrack coils (~ 11.5 cm coil to iron gap)**



UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J

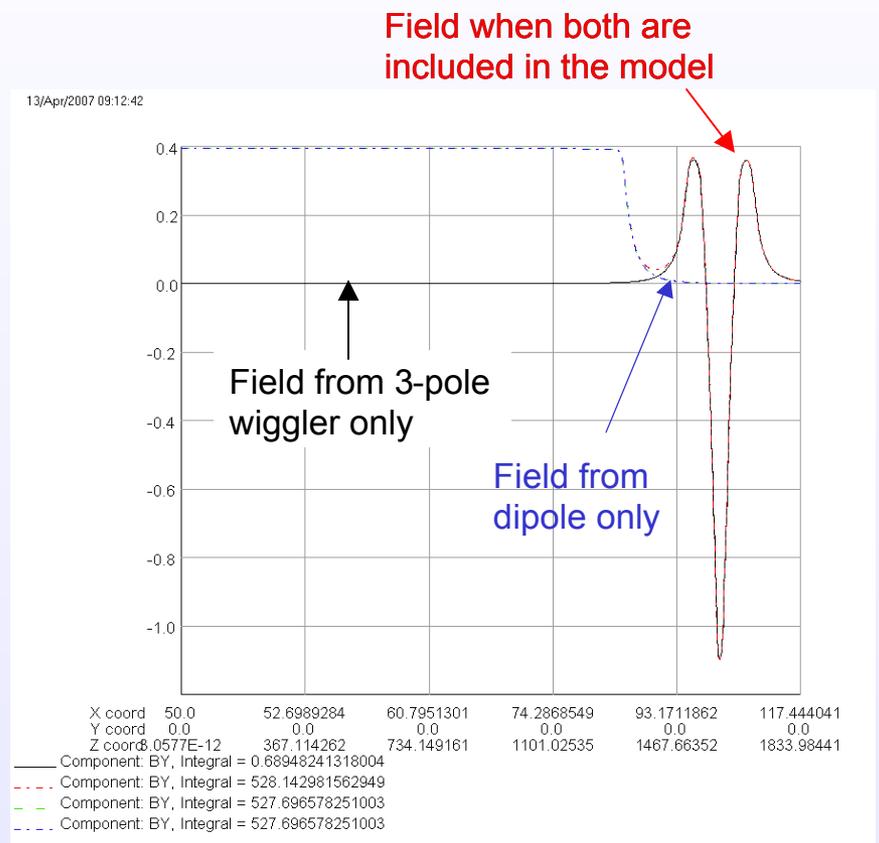
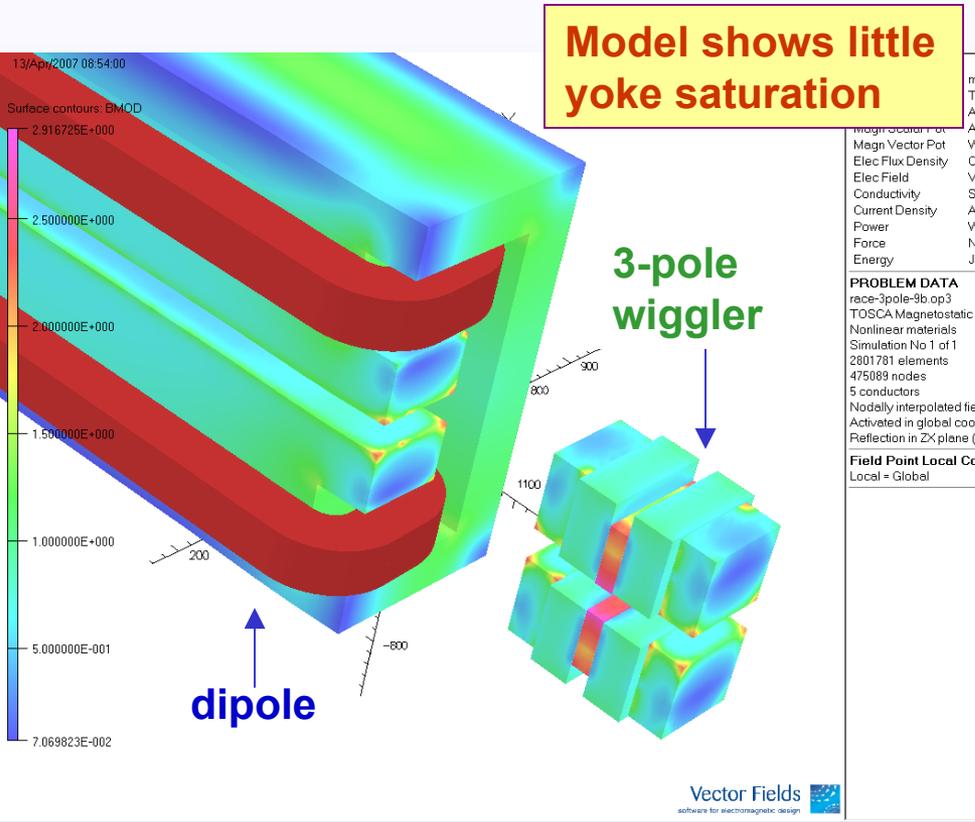
PROBLEM DATA	
race-3pole-9a.op3	
TOSCA Magnetostatic	
Nonlinear materials	
Simulation No 1 of 1	
2601781 elements	
475089 nodes	
5 conductors	
Nodally interpolated fields	
Activated in global coordinate	
Reflection in ZX plane (Z=X field)	

Field Point Local Coordinate	
Local = Global	



• There is virtually no interference (within computational error, < few parts in 1,000) between the fields of three pole wiggler and dipole.

Newer design with 2" diameter enclosed racetrack coils (~ 18 cm coil to iron gap)



- There is virtually no interference (< few parts in 1,000) between the fields of three pole wiggler and dipole.
- This design allows racetrack coils and ~18 cm of free space for whatever purpose at the expense of a little extra iron !

Larger Aperture (~90 mm) Dipole

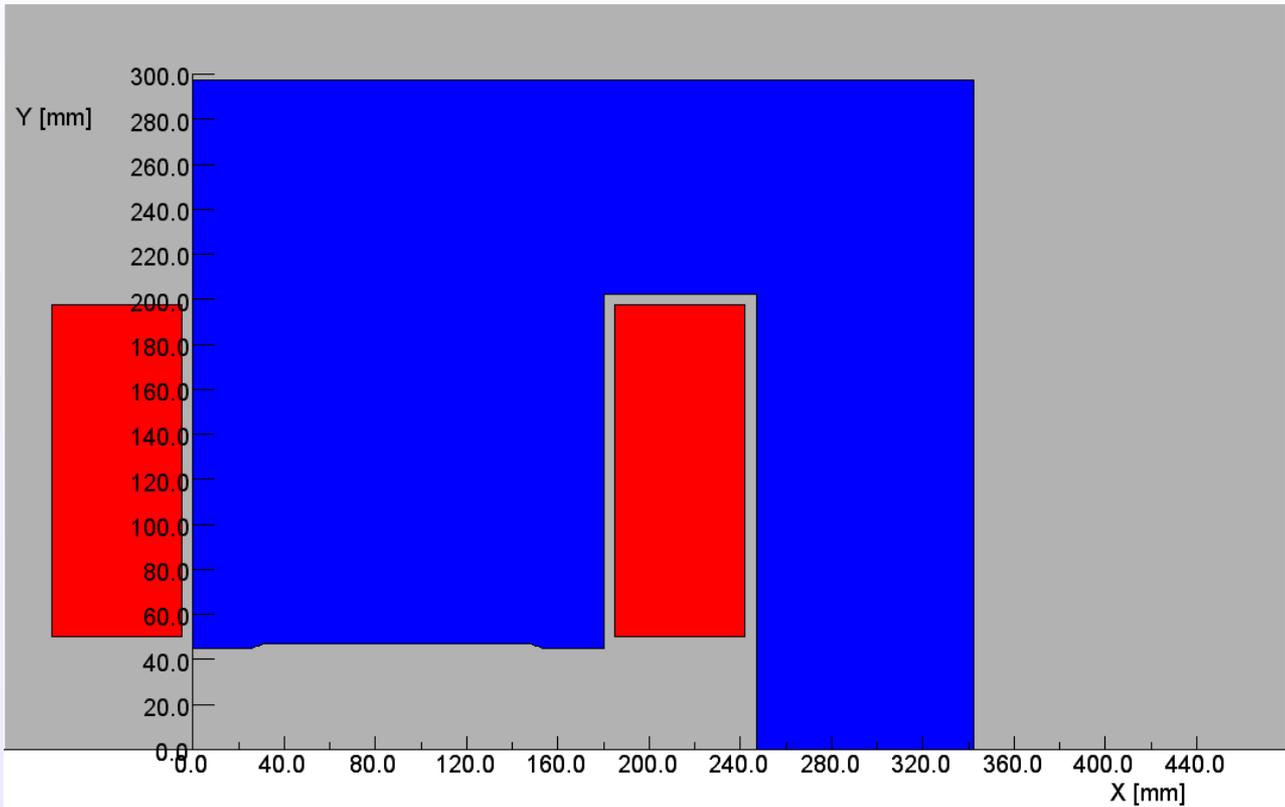
First optimized design of the larger aperture (90 mm) dipole:

- A number of 2-d designs have been examined.
- Yoke and coil cross sections are examined to make them as small as possible while satisfying the field quality requirements.
- 3-d design (which takes much longer) will be optimized next.
- The desired goal is that the two dipoles (35 mm and 90 mm) run from the power supply.
- In 2-d design, the goal is to obtain that within a few percent and then re-optimized the 90 mm dipole design after comparing 3-d profiles.
- Note that 90 mm pole gap is just a nominal number and it can be a few mm more to obtain a better compliance of the transfer function matching.

Larger Aperture (~90 mm) Dipole

Superconducting
Magnet Division

Same conductor is chosen as in 35 mm dipole. The number of turns are adjusted. Transfer function of this dipole is similar to 35 mm aperture dipole (~1% deviation).



UNITS	
Length	: mm
Flux density	: T
Field strength	: A m ⁻¹
Potential	: Wb m ⁻¹
Conductivity	: S m ⁻¹
Source density	: A mm ⁻²
Power	: W
Force	: N
Energy	: J
Mass	: kg

PROBLEM DATA	
E:\opera\ls2\90mm\ls2-cu	-90mm-e1.st
Linear elements	XY symmetry
Vector potential	Magnetic fields
Static solution	Scale factor = 1.0
60704 elements	30583 nodes
23 regions	

09/Mar/2007 09:10:32 Page 5

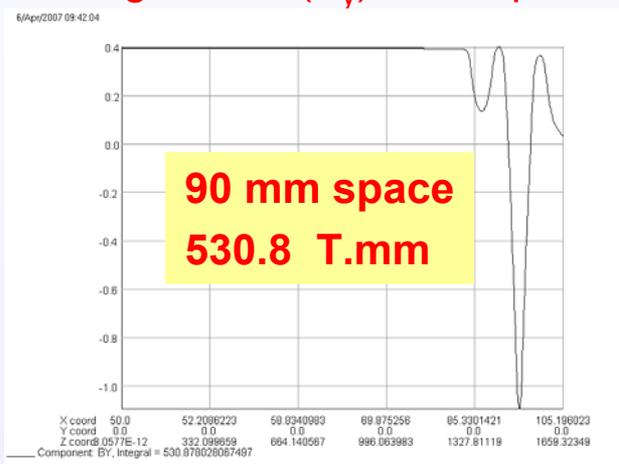
- The above initial design meets the following stated requirements:**
- o Nominal Field – $B_0 = 0.40T$ to $0.50T$
 - o Field Homogeneity $B_X, B_Y = 1 \times 10^{-4}$
 - o Good field region $B_X \pm 20mm, B_Y \pm 10mm$
 - o Nominal Current density in the coil cross section 2 Amps/mm^2

Slides from the supposedly last presentation
(not shown)

Comparison of Integral Field

**Superconducting
Magnet Division**

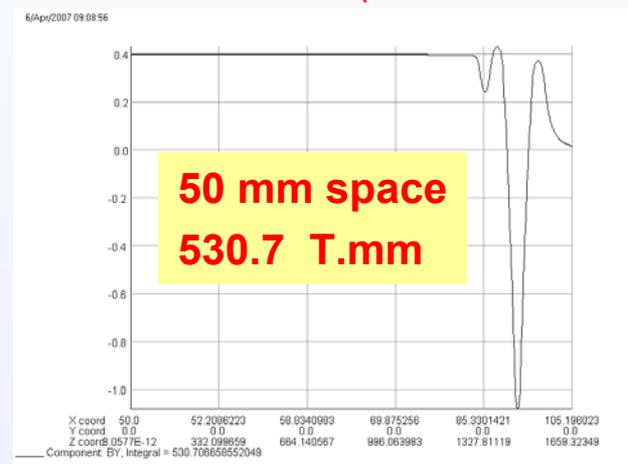
Integral field (B_y) of $\frac{1}{2}$ dipole by itself in this model is: 531.8 T.mm (error ~ 0.6 T.mm).



UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J

PROBLEM DATA	
Model:	ipole-6a.op3
TOSCA:	Magnetostatic
Nonlinear materials:	
Simulation No 1 of 1:	
252927 elements	
448143 nodes	
5 conductors	
Nodally interpolated fields:	
Activated in global coordinates:	

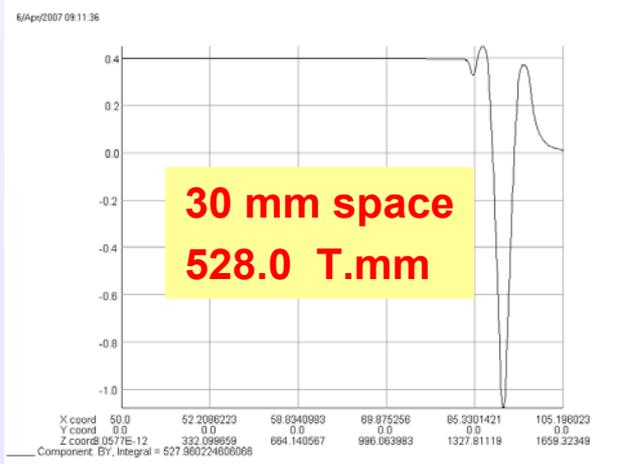
Field Point Local Coordinates	
Local = Global	



UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J

PROBLEM DATA	
Model:	ipole-6a.op3
TOSCA:	Magnetostatic
Nonlinear materials:	
Simulation No 1 of 1:	
255232 elements	
44888 nodes	
5 conductors	
Nodally interpolated fields:	
Activated in global coordinates:	

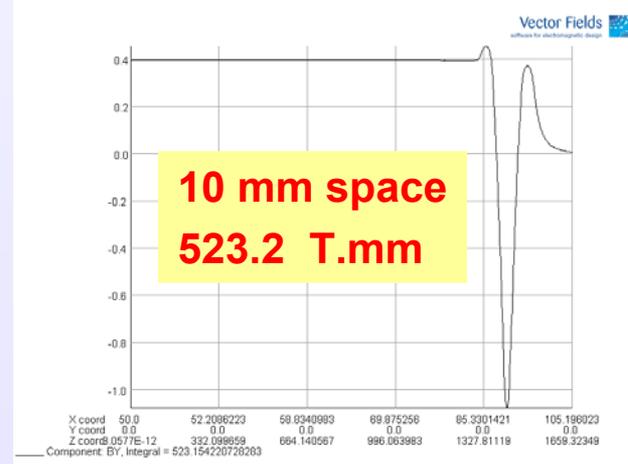
Field Point Local Coordinates	
Local = Global	



UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J

PROBLEM DATA	
Model:	ipole-6a.op3
TOSCA:	Magnetostatic
Nonlinear materials:	
Simulation No 1 of 1:	
257157 elements	
453160 nodes	
5 conductors	
Nodally interpolated fields:	
Activated in global coordinates:	

Field Point Local Coordinates	
Local = Global	



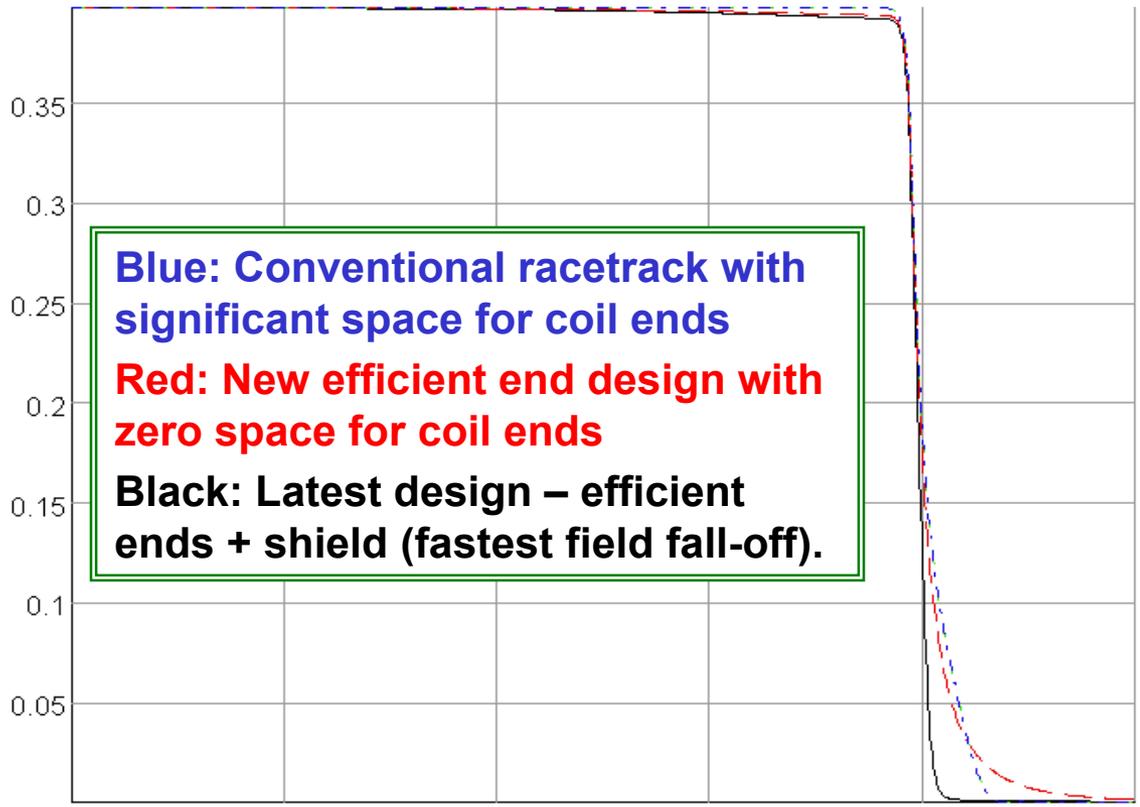
UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J

PROBLEM DATA	
Model:	ipole-6a.op3
TOSCA:	Magnetostatic
Nonlinear materials:	
Simulation No 1 of 1:	
255404 elements	
44982 nodes	
5 conductors	
Nodally interpolated fields:	
Activated in global coordinates:	

Field Point Local Coordinates	
Local = Global	



Comparison of the End Fields in Various Designs



Blue: Conventional racetrack with significant space for coil ends
Red: New efficient end design with zero space for coil ends
Black: Latest design – efficient ends + shield (fastest field fall-off).

Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J

PROBLEM DATA
 racetrk-only-6l.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 2671597 elements
 453160 nodes
 3 conductors
 Nodally interpolated fields
 Activated in global coordinates

Field Point Local Coordinates
 Local = Global

X coord	50.0	52.2086223	58.8340983	69.875256	85.3301421	105.196023
Y coord	0.0	0.0	0.0	0.0	0.0	0.0
Z coord	3.0577E-12	332.099659	664.140567	996.063983	1327.81119	1659.32349

- Component: BMOD, Integral = 524.711552367817
- Component: BMOD, Integral = 531.804875860282
- Component: BMOD, Integral = 533.087048290844
- - Component: BMOD, Integral = 533.087048290844